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(54) **Composite nonwoven web material and method of formation thereof.**

(57) Composite nonwoven web materials and methods of forming the same are disclosed. The composite nonwoven web materials are formed by hydraulically entangling a laminate of (a) at least one layer of meltblown fibers and (b) at least one layer of nonwoven material. The nonwoven material can comprise at least one of pulp fibers, staple fibers, meltblown fibers and substantially continuous filaments. The nonwoven material can also be a net, foam, etc.

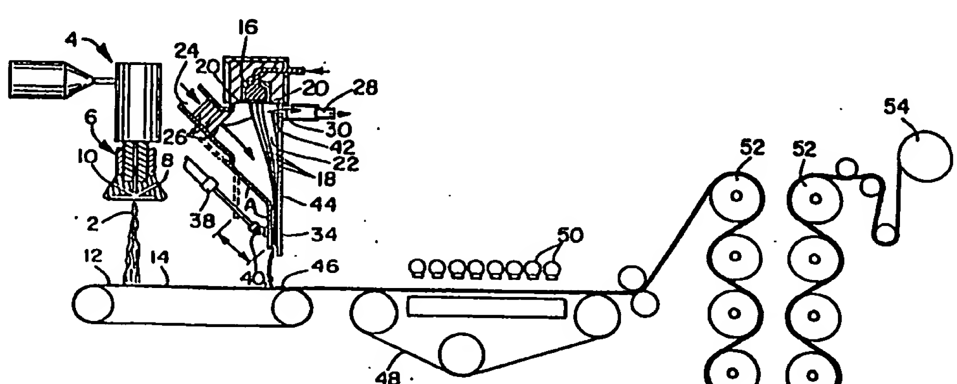

FIG. 1

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The present invention relates to a nonwoven material, and to methods of forming such nonwoven nonelastic material.

It has been desired to provide a nonwoven material having improved hand and drape without sacrificing strength and integrity.

U.S. Patent No. 3,485,706 to Evans, the contents of which are incorporated herein by reference, discloses a textile-like nonwoven fabric and a process and apparatus for its production, wherein the fabric has fibers randomly entangled with each other in a repeating pattern of localized entangled regions interconnected by fibers extending between adjacent entangled regions. The process disclosed in this patent involves supporting a layer of fibrous material on an apertured patterning member for treatment, jetting liquid supplied at pressures of at least 13.8 bar (200 pounds per square inch (psi)) to form streams having over 4.83 kJ/cm^2•s energy flux (23,000 foot-poundals/inch^2• second) at the treatment distance, and traversing the supporting layer of fibrous material with the streams to entangle fibers in a pattern determined by the supporting member, using a sufficient amount of treatment to produce uniformly patterned fabric. The initial material is disclosed to consist of any web, mat, batt or the like of loose fibers disposed in random relationship with one another or in any degree of alignment.

U.S. Reissue Patent No. 31,601 to Ikeda et al discloses a fabric, useful as a substratum for artificial leather, which comprises a woven or knitted fabric constituent and a nonwoven fabric constituent. The nonwoven fabric constituent consists of numerous extremely fine individual fibers which have an average diameter of 0.1 to 6.0 µm and are randomly distributed and entangled with each other to form a body of nonwoven fabric. The nonwoven fabric constituent and the woven or knitted fabric constituent are superimposed and bonded together, to form a body of composite fabric, in such a manner that a portion of the extremely fine individual fibers and the nonwoven fabric constituent penetrate into the inside of the woven or knitted fabric constituent and are entangled with a portion of the fibers therein. The composite fabric is disclosed to be produced by superimposing the two fabric constituents on each other and jetting numerous fluid streams ejected under a pressure of from 15 to 100 kg/cm^2 toward the surface of the fibrous web constituent. This patent discloses that the extremely fine fibers can be produced by using any of the conventional fiber-producing methods, preferably a meltblown method.

U.S. Patent No. 4,190,695 to Niederhauser discloses lightweight composite fabrics suitable for general purpose wearing apparel, produced by a hydraulic needling process from short staple fibers and a substrate of continuous filaments formed into an ordered cross-directional array, the individual continuous filaments being interpenetrated by the short staple fibers and locked in place by the high frequency of staple fiber reversals. The formed composite fabrics can retain the staple fibers during laundering, and have comparable cover and fabric aesthetics to woven materials of higher basis weight.

U.S. Patent No. 4,426,421 to Nakamae et al discloses a multi-layer composite sheet useful as a substrate for artificial leather, comprising at least three fibrous layers, namely, a superficial layer consisting of spun-laid extremely fine fibers entangled with each other, thereby forming a body of a nonwoven fibrous layer; an intermediate layer consisting of synthetic staple fibers entangled with each other to form a body of nonwoven fibrous layer; and a base layer consisting of a woven or knitted fabric. The composite sheet is disclosed to be prepared by superimposing the layers together in the aforementioned order and, then, incorporating them together to form a body of composite sheet by means of a needle-punching or water-stream-ejecting under a high pressure. This patent discloses that the spun-laid extremely fine fibers can be produced by the meltblown method.

U.S. Patent No. 4,442,161 to Kirayoglu et al discloses a spunlaced (hydraulically entangled) nonwoven fabric and a process for producing the fabric, wherein an assembly consisting essentially of wood pulp and synthetic organic fibers is treated, while on a supporting member, with fine columnar jets of water. This patent discloses it is preferred that the synthetic organic fibers be in the form of continuous filament nonwoven sheets and that the wood pulp fibers be in the form of paper sheets.

U.S. Patent No. 4,476,186 to Kato et al discloses an entangled nonwoven fabric which includes a portion (a) comprised of fiber bundles of ultrafine fibers having a size not greater than about 0.055 tex (0.5 denier), which bundles are entangled with one another, and a portion (b) comprised of - ultrafine fibers to fine bundles of ultrafine fibers branching from the ultrafine bundles, which ultrafine bundles and fine bundles of ultrafine fibers are entangled with one another, and in which both portions (a) and (b) are non-uniformly distributed in the direction of fabric thickness.

U.S. Patent 4,041,203 to Brock et al discloses a nonwoven fabric-like material comprising an integrated mat of generally discontinuous, thermoplastic polymeric microfibers and a web of substantially continuous and randomly deposited, molecularly oriented filaments of a thermoplastic polymer. The polymeric microfibers have an average fiber diameter of up to about 10 µm while the average diameter of filaments in the continuous filament web is in excess of about 12 µm Attachment between the microfiber mat and

continuous filament web is achieved at intermittent discrete regions in a manner so as to integrate the continuous filament web into an effective load-bearing constituent of the material. It is preferred that the discrete bond regions be formed by the application of heat and pressure at the intermittent areas. Other methods of ply attachment such as the use of independently applied adhesives or mechanically interlocking the fibers such as by needling techniques or the like can also be used. Other fabrics employing meltblown microfibers are disclosed in U.S. Patent Nos. 3,916,447 to Thompson and 4,379,192 to Wahlquist et al.

U.S. Patent No. 4,514,455 to Hwang discloses a composite nonwoven fabric which comprises a batt of crimped polyester staple fibers and a bonded sheet of substantially continuous polyester filaments. The batt and the sheet are in surface contact with each other and are attached to each other by a series of parallel seams having a spacing of at least 1.7 cm, and preferably no greater than 5 cm, between successive seams. In one embodiment of Hwang, the seams are jet tracks which are a result of hydraulic stitching.

However, it is desired to provide a nonwoven web material having improved hand and drape and in which the strength (wet and dry) of the web remains high. Moreover, it is desired to provide a cloth-like fabric which can have barrier properties and high strength. Furthermore, it is desired to provide a process for producing such material which allows for control of other product attributes, such as absorbency, wet strength, durability, low linting, etc.

The invention aims in achieving these objects. These objects are achieved by the composite nonwoven laminate web material as described in independent claim 1 and the process of forming same described in independent claim 18. Further advantageous features of the web and the process are evident from the dependent claims.

The invention provides nonwoven fibrous hydraulically entangled web material, wherein the nonwoven hydraulically entangled material is a hydraulically entangled web of at least one layer of meltblown fibers and at least one layer of nonwoven, e.g. fibrous, material such as pulp fibers, staple fibers, meltblown fibers, continuous filaments, nets, foams, etc. Such material has applications for wipes, tissues, bibs, napkins, cover-stock or protective clothing substrates, diapers, feminine napkins, laminates and medical fabrics, among other uses.

According to the invention, a composite nonwoven web material is formed by hydraulically entangling a laminate of (1) at least one layer of meltblown fibers and (2) at least one layer of nonwoven, e.g. fibrous material such as a layer of at least one of pulp fibers, staple fibers, meltblown fibers, continuous filaments, nets, foams, etc., so as to provide a nonwoven non-elastic web material. Preferably, the meltblown fiber layer and the nonwoven material layer are each made of non-elastic material.

The use of meltblown fibers as part of the structure (e.g., laminate) subjected to hydraulic entangling facilitates entanglement of the various fibers and/or filaments. This results in a higher degree of entanglement and allows the use of a wider variety of other fibrous material in the laminate. Moreover, the use of meltblown fibers can decrease the amount of energy needed to hydraulically entangle the laminate. In hydraulic entangle bonding technology, sometimes referred to as "spunlace", typically a sufficient number of fibers with loose ends (e.g., staple fibers and wood fibers), small diameters and high fiber mobility are incorporated in the fibrous webs to wrap and entangle around fiber filament, foam, net, etc., cross-over points, i.e., "tying knots." Without such fibers, bonding or the web is quite poor. Continuous large diameter filaments which have no loose ends and are less mobile have normally been considered poor fibers for entangling. However, meltblown fibers have been found to be effective for wrapping and entangling or intertwining. This in due to the fibers having small diameters and a high surface area, and the fact that when a high enough energy flux is delivered from the jets, fibers break up, are mobilized and entangle other fibers. This phenomenon occurs regardless of whether meltblown fibers are in the aforementioned layered forms or in admixture forms.

The use of meltblown fibers (e.g., microfibers) provides an improved product in that the tying off among the meltblown fibers and other, e.g., fibrous, material in the laminate is improved. Thus, due to the relatively great length and relatively small thickness of the meltblown fibers, wrapping of the meltblown fibers around the other material in the laminate is enhanced. Moreover, the meltblown fibers have a relatively high surface area, small diameters and are sufficient distances apart from one another to allow other fibrous material in the laminate to freely move and wrap around and within the meltblown fibers. In addition, because the meltblown fibers are numerous and have a relatively high surface area, small diameter and are nearly continuous, such fibers are excellent for anchoring (bonding) loose fibers (e.g., wood fibers and staple fibers) to them. Anchoring or laminating such fibers to meltblown fibers requires relatively low amounts of energy to entangle.

The use of hydraulic entangling techniques, to mechanically entangle (e.g., mechanically bond) the fibrous material, rather than using only other bonding techniques, including other mechanical entangling techniques, provides a composite nonwoven fibrous web material having increased strength, integrity and

hand and drape, and allows for better control of other product attributes, such as absorbency, wet strength, etc.

Figure 1 is a schematic view of an apparatus for forming a composite nonwoven web material of the present invention;

Figures 2A and 2B are photomicrographs 157x and 80x linear magnification, respectively, of respective sides of one example of a composite nonwoven material of the present invention.

Figures 3A and 3B are phototmicrographs 82x and 89x linear magnificaiton, respectively of respective sides of another example of a composite nonwoven material of the present invention; and

Figures 4A and 4B are photomicrographs 85x and 85x linear magnification, respectively, of still another example of a composite nonwoven material of the present invention.

While the invention will be described in connection with the specific and preferred embodiments, it will be understood that it is not intended to limit the invention to those embodiments.

The present invention contemplates a composite nonwoven web of a hydraulically entangled laminate, and a method of forming the same, which involves processing of a laminate of at least one layer of meltblown fibers and at least one layer of nonwoven material. The laminate is hydraulically entangled, that is, a plurality of high pressure liquid columnar streams are jetted toward a surface of the laminate.

By a nonwoven layer, we mean a layer of material which does not embody a regular pattern of mechanically interengaged strands, strand portions or strand-like strips, i.e., is not woven or knitted.

The fibers or filaments can be in the form of, e.g., webs, batts, loose fibers, etc. The laminate can include other, e.g., fibrous, layers.

Fig. 1 schematically shows an apparatus for producing the composite nonwoven web material of the present invention.

A gas stream 2 of meltblown microfibers, preferably non-elastic meltblown microfibers, is formed by known meltblowing techniques on conventional meltblowing apparatus generally designated by reference numeral 4, e.g., as discussed in U.S. Patent No. 3,849,241 to Buntin et al and U.S. Patent No. 4,048,364 to Harding et al, the contents of each of which are incorporated herein by reference. Basically, the method of formation involves extruding a molten polymeric material through a die head generally designated by the reference numeral 6 into fine streams and attenuating the streams by converging flows of high velocity, heated fluid (usually air) supplied from nozzles 8 and 10 to break the polymer streams into fibers of relatively small diameter. The die head preferably includes at least one straight row of extrusion apertures. The fibers can be micro fibers or macrofibers depending on the degree of attenuation. Microfibers are subject to a relatively greater attenuation and can have a diameter of up to about 20 μm , but are generally approximately 2 to 12 μm in diameter. Macrofibers generally have a larger diameter, i.e., greater than about 20 μm , e.g., 20-100 μm , usually about 50 μm The gas stream 2 is collected on, e.g., belt 12 to form meltblown web 14.

In general, any thermoformable polymeric material, especially non-elastic thermoformable material, is useful in forming meltblown fibers such as those disclosed in the aforementioned Buntin et al patents. For example, polyolefins such as polypropylene and polyethylene, polyamides and polyesters such as polyethylene terephthalate can be used, as disclosed in U.S. Patent No. 4,100,324, the contents of which are incorporated herein by reference. Polypropylene, polyethylene, polyethylene terephthalate, polybutylene terephthalate and polyvinyl chloride are preferred non-elastic materials. Non-elastic polymeric material, e.g., a polyolefin, is most preferred for forming the meltblown fibers in the present invention. Copolymers of the foregoing materials may also be used.

The meltblown layer 14 can be laminated with at least one nonwoven, preferably non-elastic, layer. The latter layer or layers can be previously formed or can be formed directly on the meltblown layer 14 via various processes, e.g., dry or wet forming, carding, etc.

The nonwoven, preferably non-elastic, layer can be made of substantially continuous filaments. The substantially continuous filaments are preferably large diameter continuous filaments such as unbonded meltspun (spunbond) filaments (e.g., meltspun polypropylene or polyester), nylon netting, scrims and yarns. An unbonded meltspun, such as a completely unbonded, e.g. 16.9 g/m^2 (0.5 oz/yd^2), web of meltspun polypropylene filaments having an average diameter of about 20 μm , is particularly preferable.

Meltspun filaments can be produced by known methods and apparatus such as disclosed in U.S. Patent No. 4,340,567 to Appel, the contents of which are incorporated herein by reference. The meltspun filament layer and the meltblown layer can be formed separately and placed adjacent one another before hydraulic entanglement or one layer can be formed directly on the other layer. For example, the meltspun filaments can be formed directly on the meltblown layer, as shown in Fig. 1. As shown schematically in this figure, a spinnerette 16 may be of conventional design and arranged to provide extrusion of filaments 18 in one or more rows of orifices 20 across the width of the device into a quench chamber 22. Immediately after

extrusion through the orifices 20, acceleration of the strand movement occurs due to tension in each filament generated by the aerodynamic drawing means. The filaments simultaneously begin to cool from contact with the bench fluid which is supplied through inlet 24 and one or more screens 26 in a direction preferably at an angle having the major velocity component in the direction toward the nozzle entrance. The quench fluid may be any of a wide variety of gases as will be apparent to those skilled in the art, but air is preferred for economy. The quench fluid is introduced at a temperature to provide for controlled cooling of the filaments. The exhaust air fraction exiting at 28 from ports 30 affects how fast quenching of the filaments takes place. For example, a higher flow rate of exhaust fluid results in more being pulled through the filaments which cools the filaments faster and increases the filament denier. As quenching is completed, the filament curtain is directed through a smoothly narrowing lower end of the quenching chamber into nozzle 32 where the air attains a velocity of about 45.7 to 288 m/sec (about 150 to 800 feet per second). The drawing nozzle is full machine width and preferably formed by a stationary wall 34 and a movable wall 36 spanning the width of the machine. Some arrangement for adjusting the relative locations of sides 34 and 36 is preferably provided such as piston 38 fixed to side 36 at 40. In a particularly preferred embodiment, some means such as fins 42 are provided to prevent a turbulent eddy zone from forming. It is also preferred that the entrance to the nozzle formed by side 36 be smooth at corner 44 and at an angle A of at least about 135° to reduce filament breakage. After exiting from the nozzle, the filaments may be collected directly on the meltblown layer 14 to form laminate 46.

When a laminate of a meltblown fiber layer and meltspun filament layer is hydraulically entangled, the web remains basically two-sided, but a sufficient amount of meltblown fibers break from the meltblown web and loop around the larger meltspun filament layers to bond the entire structure. While a small amount of entanglement also occurs between meltspun filaments, most of the bonding is due to meltblown fibers entangling around and within meltspun filaments.

If added strength is desired, the hydraulically entangled laminate or admixture can undergo additional bonding (e.g., chemical or thermal). In addition, bicomponent and shaped fibers, particulates (e.g., as part of the meltblown layer), etc., can further be utilized to engineer a wide variety of unique cloth-like fabrics.

A fabric with cloth-like hand, barrier properties, low linting and high strength can also be obtained by hydraulically entangling a laminate of a sheet of cellulose. (e.g., wood or vegetable pulp) fibers and web of thermoplastic meltblown fibers. After being mechanically softened, the hand of the materials can be vastly improved. In addition, barrier properties and selective absorbency can be incorporated into the fabric. Such fabrics are very similar, at low basis weights, to pulp coform. Also, the versatility of the meltblown process (i.e., adjustable porosity/fiber size), paper-making techniques (e.g., wet forming, softening, sizing, etc.) and the hydraulic entangling process enable other beneficial attributes to be achieved, such as improved absorbency, abrasion resistance, wet strength and two-sided absorbency (oil/water). Terrace Bay Long Lac-19 wood pulp, which is a bleached Northern softwood kraft pulp composed of fiber having an average length of 2.6 millimeters, and Southern Pine, e.g., K-C Coosa CR-55, with an average length of 2.5 millimeters are particularly preferred cellulose materials. Cotton pulp such as cotton linters and refined cotton can also be used.

Cellulose fibers can also be hydraulically entangled into a meltspun/meltblown laminate. For example, a sheet of wood pulp fibers, e.g., ECH Croften kraft (70% Western red cedar/30% hemlock), can be hydraulically entangled into a laminate of meltspun polypropylene filaments with an average denier of 0.176 tex/filament (1.6 d.p.f.) and meltblown polypropylene fibers with an average size of 2-12 · µm.

A layer of staple fibers, e.g., wool, cotton (e.g., cotton linters), rayon and polyethylene can, e.g., be layered on an already formed meltblown web. The staple fibers can be in the form of, e.g., webs, batts, loose fibers, etc. Examples of various materials and methods of forming staple fiber layers and hydraulically entangling the same are disclosed in the aforementioned U.S. Patent No. 3,485,706 to Evans. The layered composite can be hydraulically entangled at operating pressures up to 1.38 bar (2,000 psi).

The pattern of entangling can be adjusted by changing the carrying wire geometry to achieve the desired strength and aesthetics. If a polyester meltblown is used as a substrate for such a structure, a durable fabric which can withstand laundering requirements can be produced.

Another meltblown web can be laminated with the already formed meltblown web. In such a case, the apparatus for forming meltspun filaments shown in Fig. 1 can be replaced with another conventional meltblowing apparatus such as that generally designated by the reference numeral 4 in Fig. 1.

Other nonwoven layers such as nets, foams, etc., as well as films, e.g., extruded films, or coatings such as latex, can also be laminated with the already formed meltblown web.

It is not necessary that the web or the layers thereof (e.g., the meltblown fibers or the meltspun filaments) be totally unbonded when passed into the hydraulic entangling step. The main criterion is that, during hydraulic entangling, sufficient "free" fibers (fibers which are sufficiently mobile) are generated to

provide the desired degree of entanglement. Thus, such sufficient mobility can possibly be provided by the force of the jets during the hydraulic entangling, if, e.g., the meltblown fibers have not been agglomerated too much in the meltblowing process. The degree of agglomeration is affected by process parameters, e.g., extruding temperature, attenuation air temperature, quench air or water temperature, forming distance, etc. Excessive fiber bonding can be avoided by rapidly quenching the gas stream of fibers by spraying a liquid thereon as disclosed in U.S. Patent No. 3,959,421 to Weber et al, the contents of which are incorporated herein by reference. Alternatively, the web can be mechanically stretched and worked (manipulated), e.g., by using grooved nips or protuberances, prior to the hydraulic entangling to sufficiently unbond the fibers.

It will be noted that the laminate or mixture subjected to hydraulic entanglement can be completely nonwoven. That is, it need not contain a woven or knitted constituent.

Suitable hydraulic entangling techniques are disclosed in the aforementioned Evans patent and an article by Honeycomb Systems, Inc., Biddeford, Maine, entitled "Rotary Hydraulic Entanglement of Nonwovens," reprinted from INSIGHT 86 INTERNATIONAL ADVANCED FORMING/BONDING CONFERENCE, the contents of which are incorporated herein by reference. For example, hydraulic entangling involves treatment of the laminate or web 46, while supported on an apertured support 48, with streams of liquid from jet devices 50. The support 48 can be a mesh screen or forming wires. The support 48 can also have a pattern so as to form a nonwoven material with such pattern. The apparatus for hydraulic entanglement can be conventional apparatus, such as described in the aforementioned U.S. Patent No. 3,485,706. On such an apparatus, fiber entanglement is accomplished by jetting liquid supplied at pressures, e.g., of at least about 13.8 bar (200 psi) to form fine, essentially columnar, liquid streams toward the surface of the supported laminate (or mixture). The supported laminate (or mixture) is traversed with the streams until the fibers are randomly entangled and interconnected. The laminate (or mixture) can be passed through the hydraulic entangling apparatus a number of times on one or both sides. The liquid can be supplied at pressures of from about 6.9 to 198 bar (100 to 3,000 psi). The orifices which produce the columnar liquid streams can have typical diameters known in the art, e.g. .0127 cm (0.005 inch) and can be arranged in one or more rows with any number of orifices, e.g., 40, in each row. Various techniques for hydraulic entangling are described in the aforementioned U.S. Patent No. 3,485,706, and this patent can be referred to in connection with such techniques.

After the laminate (or mixture) has been hydraulically entangled, it can be dried by a through drier and/or the drying cans 52 and wound on winder 54. Optionally, after hydraulic entanglement, the web can be further treated, such as by thermal bonding, coating, softening, etc.

Figs. 2A and 2B are photomicrographs of a wood fiber/spunbond/meltblown laminate which has been hydraulically entangled at a line speed of 7.015 m/min (23 fpm) at 41, 41, 41 bar (600, 600, 600 psi) from the wood fiber side on a 100 x 92 mesh. In particular, the laminate was made of 34 gsm red cedar, 14 gsm spunbond polypropylene and 14 gsm meltblown polypropylene. The wood fiber side is shown face up in Fig. 2A and the meltblown side is shown face up in Fig. 2B.

Figs. 3A and 3B are photomicrographs of a meltblown/spunbond laminate which has been hydraulically entangled at a line speed of 7.015 m/min (23 fpm) at 13.8, 28, 55,82, 82, 82 bar (200, 400, 800, 1200, 1200, 1200 psi) from the meltblown side on a 100 x 92 mesh. In particular, the laminate was made of 17 gsm meltblown polypropylene and 17 gsm spunbond polypropylene. The meltblown side is shown face up in Fig. 3A and the spunbond side is face up in Fig. 3B.

Figs. 4A and 4B are photomicrographs of a meltblown/spunbond/meltblown laminate which has been hydraulically entangled at a line speed of 23 fpm three times on each side at 42 bar (700 psi) on a 100 x 92 mesh as described in Example 3. The first side entangled is shown face up in Fig. 4A and the last side entangled is race up in Fig. 4B.

Various examples of processing conditions will be set forth as illustrative of the present invention. Of course, such examples are illustrative and are not limiting. For example, commercial line speeds are expected to be higher, e.g. 122 m/min (400 fpm) or above. Based on sample work, line speeds of e.g. 305 or 610 m/min (1,000 or 2,000 fpm) may be possible.

In the following examples, the specified materials were hydraulically entangled under the specified conditions. The hydraulic entangling was carried out using hydraulic entangling equipment similar to conventional equipment, having jets with 0.005 inch orifices, 40 orifices per inch, and with one row of orifices. The percentages given refer to weight percents.

Example 1

A laminate of wood fiber/meltblown fiber/wood fiber was provided. Specifically, the laminate contained a layer of wood fiber containing 60% Terrace Bay Long Lac-19 wood pulp and 40% eucalyptus (the layer

having a basis weight of 15 gsm), a layer of meltblown polypropylene (basis weight of 10 gsm) and a layer of wood fiber containing 60% Terrace Bay Long Lac-19 wood pulp and 40% eucalyptus (basis weight of 15 gsm). The estimated basis weight of this laminate was 45 gsm. The laminate was hydraulically entangled at a processing speed of 7.015 m/min (23 fpm) by making three passes through the equipment on each side at 27.6 bar (400 psi). A 100 x 92 wire mesh was used as the support during the hydraulic entanglement.

Example 2

A staple fiber/meltblown fiber/staple fiber laminate was hydraulically entangled. Specifically, a first layer of rayon staple fibers (basis weight of 14 gsm) was laminated with a second layer of meltblown polypropylene fibers (basis weight of 10 gsm) and a third layer of polypropylene staple fibers (basis weight of 15 gsm). The laminate had an estimated basis weight of 38 gsm. Using a processing speed of 7.015 m/min (23 fpm) and a 100 x 92 wire mesh support, the laminate was hydraulically entangled three times on each side at 41 bar (600 psi) with the rayon side being entangled first.

Example 3

A meltblown polypropylene/spunbond polypropylene/-meltblown polypropylene laminate was hydraulically entangled. Specifically, a laminate of meltblown polypropylene (basis weight of 10 gsm), spunbond polypropylene (basis weight of 10 gsm) and meltblown polypropylene (basis weight of 10 gsm) having an estimated basis weight of 30 gsm was hydraulically entangled at a processing speed of 7.015 m/min (23 fpm) using a 100 x 92 wire mesh support. The laminate was entangled three times on each side at 42 bar (700 psi).

Example 4

A wood fiber/spunbond polypropylene/meltblown polypropylene laminate was hydraulically entangled. Specifically, a laminate of Terrace Bay Long Lac-19 (basis weight of 20 gsm), spunbond polypropylene (basis weight of 10 gsm) and meltblown polypropylene (basis weight of 10 gsm) having an estimated basis weight of 40 gsm was hydraulically entangled at a processing speed of 7.015 m/min (23 fpm) on a 100 x 92 wire mesh support. The laminate was entangled on the first side only at 34.5 bar (500 psi) for three passes.

Physical properties of the materials of Examples 1 through 4 were measured in the following manner:

The bulk was measured using an Ames bulk or thickness tester (or equivalent) available in the art. The bulk was measured to the nearest .00254 cm (0.001 inch).

The basis weight and MD and CD grab tensiles were measured in accordance with Federal Test Method Standard No. 191A (Methods 5041 and 5100, respectively).

The absorbency rate was measured on the basis of the number of seconds to completely wet each sample in a constant temperature water bath and oil bath.

A "cup crush" test was conducted to determine the softness, i.e., hand and drape, of the samples. This test measures the amount of energy required to push, with a foot or plunger, the fabric which has been pre-seated over a cylinder or "cup." The lower the peak load of a sample in this test, the softer, or more flexible, the sample. Values below 100 to 150 grams correspond to what is considered a "soft" material. The results of these tests are shown in Table 1.

The Frazier test was used to measure the permeability of the samples to air in accordance with Federal Test Method Standard No. 191A (Method 5450).

In this Table, for comparative purposes, are set forth physical properties of two known hydraulically entangled nonwoven fibrous materials, Sontara®8005, a spunlaced fabric of 100% polyester staple fibers 0.15 tex/filament x 1.9 cm (1.35 d.p.f. x 3/4") from E.I. DuPont de Nemours and Company and Optima®, a wood pulp-polyester converted product from American Hospital Supply Corp.

TABLE 1

Example	Basis Weight g/m² (gsm)	Bulk cm (in)	MD GRAB TENSILES Peak Energy nm (in-lb)	Peak Load kg (lbs.)	Peak Elongation cm (in)	Peak Strain (%)	Fail Energy nm (in-lb)
1	44	.069 (.027)	.09 (0.8)	0.7 (1.6)	2.0 (0.8)	26.3	.18 (1.6)
2	43	.07 (.028)	.61 (5.4)	3.2 (7.0)	4.3 (1.7)	56.7	1.3 (11.9)
3	33	.10 (.040)	2.7 (24.1)	5.16(11.4)	10.1 (4.0)	132.7	4.8 (42.6)
4	41	.06 (.025)	3.1 (27.5)	6.5 (14.4)	8.4 (3.3)	108.7	5.3 (46.5)
Sontara® 8005	65	.05 (.020)	2.27(20.1)	19.2(42.3)	2.54(1.0)	34.6	4.5 (40.4)
Optima®	72	.05 (.020)	1.45(12.9)	11.9(26.3)	2.54(1.0)	33.8	3.9 (35.1)

(continued)

$* CFM/ft^2 = 0.3 m^3/min/m^2$

TABLE 1 (cont.)

Example	CD GRAB TENSILES: Peak Energy nm (in-lb)	Peak Load kg (lbs)	Peak Elongation cm (in)	Peak Strain (%)	Fail Energy nm (in-lb)	Water Sink (sec)	Oil Sink (sec)	*Frazier Test (CFM/ft² @ 0.5"H₂O)	Cup Crush: Peak Load (grams)	Total Energy (grams/mm)
1	0.12 (1.1)	0.7 (1.6)	3.3 (1.3)	43.2	0.25 (2.3)	1.2/<.1*	0,7	112	—	—
2	0.38 (3.4)	1.2 (2.7)	7.2 (2.8)	92.8	0.7 (6.4)			179	32	352
3	2.9 (26.4)	1.6 (10.8)	10.6 (4.2)	139.2	5.2 (46.2)			188	30	423
4	2.6 (23.3)	5.7 (12.8)	8.5 (3.4)	112.5	4.3 (38.2)			228	—	—
Sontara® 8005	2.59 (23.0)	8.4 (18.5)	10.1 (4.0)	134.3	4.4 (39.8)				89	1537
Optima®	1.87 (16.6)	10.0 (22.1)	5.3 (2.1)	71.0	3.6 (32.0)	60+	60+	85	196	3522

* Surfactant treated with Rohm & Haas Triton X-102

As can be seen in the foregoing Table 1, nonwoven fibrous material within the scope of the present invention has a superior combination of properties of strength, drape and hand. Use of microfiber, as compared to carded webs or staple fibers, etc., gives a "fuzzy surface" thereby producing a softer-feeling product.

The material is also softer (less rough) than spunbond or other bonded (adhesive, thermal, etc.) material. Use of meltblown fibers produces a material having more covering power than with other types of webs.

The present invention provides a web which is very useful for manufacturing disposable material such as work wear, medical fabrics, disposable table linens, etc. The material has high abrasion resistance. Because of Z-direction fibers, it also has good transfer (e.g., liquid transfer) properties, and has good prospects for absorbents. The material may also be used for diaper covers because it has a cottony feel.

The use of spunbond fibers produces a product which has very high strength. Cellulose/meltblown hydraulically entangled laminates have much higher strength than tissue. The hydraulically entangled product has isotropic elongation (extensibility), not only elongation in the CD direction. The hydraulically entangled products have good hand.

This case is one of a group of cases which are being filed on the same date. The group includes (1) "NONWOVEN FIBROUS ELASTOMERIC WEB MATERIAL AND METHOD OF FORMATION THEREOF", L. Trimble et al EP 0 333 209-A (K.C. Ser. No. 7982, Our File No. K5016-EP), (2) "NONWOVEN FIBROUS NON-ELASTIC MATERIAL AND METHOD OF FORMATION THEREOF", F. Radwanski et al EP 0 333 228-A (K.C. Ser. No. 7978, Our K 5015-EP),(3) "NONWOVEN ELASTOMERIC WEB AND METHOD OF FORMING THE SAME", F. Radwanski et al EP 333 212-A (K.C. Ser. No. 7975, Our File No. K5018-EP), (4) "COMPOSITE NONWOVEN NON-ELASTIC WEB MATERIAL AND METHOD OF FORMATION THEREOF", F. Radwanski et al EP 333 211-A (K.C. Ser. No. 7974, Our file No. K5019-EP) and (5) "BONDED NONWOVEN MATERIAL; METHOD AND APPARATUS FOR PRODUCING THE SAME", F. Radwanski, EP 0 333 210-A (K.C. Ser. No. 8030, Our File No. K5017-EP).

The contents of the other applications in this group, over than the present application, are incorporated herein by reference.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto, but is susceptible of numerous changes and modifications as are known to one having ordinary skill in the art, and we therefor do not wish to be limited to the details shown and described herein, but intend to cover all such modifications as are encompassed by the scope of the appended claims.

Claims

1. A composite nonwoven laminate web material comprising (a) at least one layer of meltblown fibers and (b) at least one layer of nonwoven material characterized in that said meltblown fibers (2) are hydraulically entangled and intertwined with said nonwoven material (b).

2. A composite nonwoven web material according to claim 1, wherein said meltblown fibers are polypropylene meltblown fibers.

3. A composite nonwoven web material according to one of the preceding claims, wherein said nonwoven material comprises substantially continuous filaments.

4. A composite nonwoven web material according to claim 3, wherein said substantially continuous filaments are spunbond filaments.

5. A composite nonwoven web material according to claim 4, wherein said spunbond filaments are formed of a material selected from the group consisting of polypropylene and polyester.

6. A composite nonwoven web material according to one of claims 1 or 2, wherein said nonwoven material comprises pulp fibers.

7. A composite nonwoven web material according to claim 6, wherein said pulp fibers are cellulose pulp fibers.

8. A composite nonwoven web material according to claim 6, wherein said pulp fibers are wood pulp fibers.

9. A composite nonwoven web material according to one of claims 1 or 2, wherein said nonwoven material comprises staple fibers.

10. A composite nonwoven web material according to claim 9, wherein said staple fibers are synthetic staple fibers.

11. A composite nonwoven web material according to claim 10, wherein said synthetic staple fibers are made of a material selected from the group consisting of rayon and polypropylene.

12. A composite nonwoven web material according to one of claims 1 or 2, wherein said nonwoven material comprises meltblown fibers.

13. A composite nonwoven web material according to claim 12, wherein said meltblown fibers are meltblown microfibers, having a diameter up to 20 μm, and preferably a diameter of 2 to 12 μm.

14. A composite nonwoven web material according to claim 12, wherein said meltblown fibers are meltblown macrofibers, having a diameter greater than 20 μm and typically a diameter of about 50 μm.

15. A composite nonwoven web material according to one of claims 1 or 2, wherein said nonwoven material comprises a net.

16. A composite nonwoven web material according to one of claims 1 or 2, wherein said nonwoven material comprises a foam material.

17. A process for forming a composite nonwoven laminate web material comprising (a) at least one layer of meltblown fibers and (b) at least one layer of nonwoven material on a support, characterized in jetting a plurality of high-pressure liquid streams toward a surface of said laminate, thereby hydraulically entangling and intertwining said meltblown fibers and said nonwoven material so as to form a nonwoven web material.

18. A process according to claim 17, wherein said nonwoven material is at least one member selected from the group consisting of pulp fibers, staple fibers, meltblown fibers, and continuous filaments.

19. A process according to one of claims 17 or 18, wherein said meltblown fibers are polypropylene meltblown fibers.

20. A process according to claim 18, wherein said substantially continuous filaments are substantially continuous synthetic filaments.

21. A process according to claim 20, wherein said substantially continuous synthetic filaments are spunbond filaments.

22. A process according to claim 21, wherein said spunbond filaments are formed of a material selected from the group consisting of polypropylene and polyester.

23. A process according to claim 18, wherein said pulp fibers are cellulose pulp fibers.

24. A process according to claim 23, wherein said cellulose pulp fibers are wood pulp fibers.

25. A process according to claim 18, wherein said pulp fibers are synthetic pulp fibers.

26. A process according to claim 25, wherein said synthetic pulp fibers have a length less than or equal to .623 cm (0.25 inches) and a tex value of less than or equal to .143 (denier less than or equal to 1.3).

27. A process according to claim 26, wherein said synthetic pulp fibers are polyester pulp fibers.

28. A process according to claim 18, wherein said staple fibers are synthetic staple fibers.

29. A process according to claim 28, wherein said synthetic staple fibers are made of a material selected from the group consisting of rayon and polypropylene.

30. A process according to one of claims 17 to 29, wherein said support is an apertured support.

31. A process according to one of claims 17 to 30, wherein said laminate on a support and said plurality of high-pressure liquid streams are moved relative to one another so that said plurality of high-pressure liquid streams traverses that length of said laminate on said support.

32. A process according to claim 31, wherein said plurality of high-pressure liquid streams traverses said laminate on said support a plurality of times.

33. A process according to one of claims 17 to 32, wherein said laminate has opposed major surfaces, and said plurality of high-pressure liquid streams are jetted toward each major surface of said laminate.

34. A process according to claim 17, wherein said nonwoven material is a net.

35. A process according to claim 17, wherein said nonwoven material is a foam.

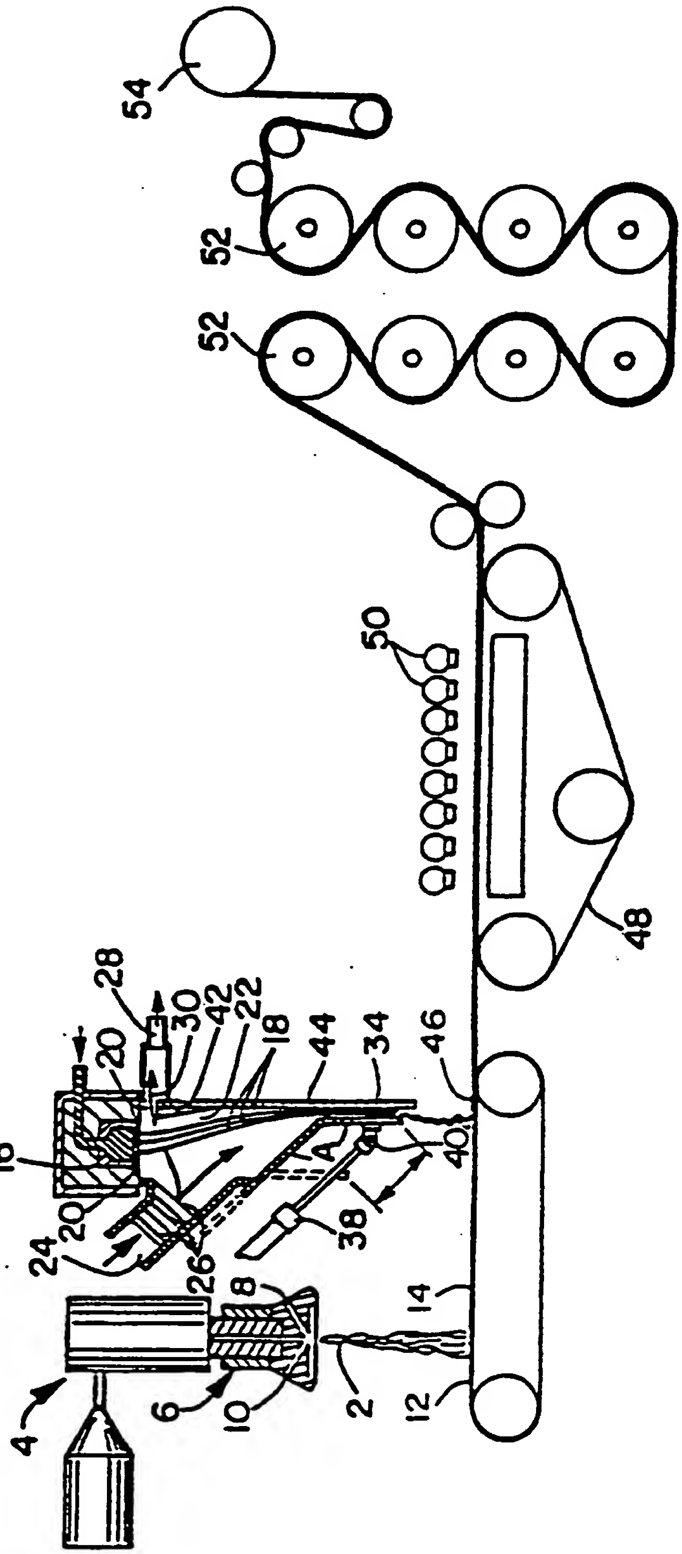
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FIG. 1

FIG. 2A

FIG. 2B

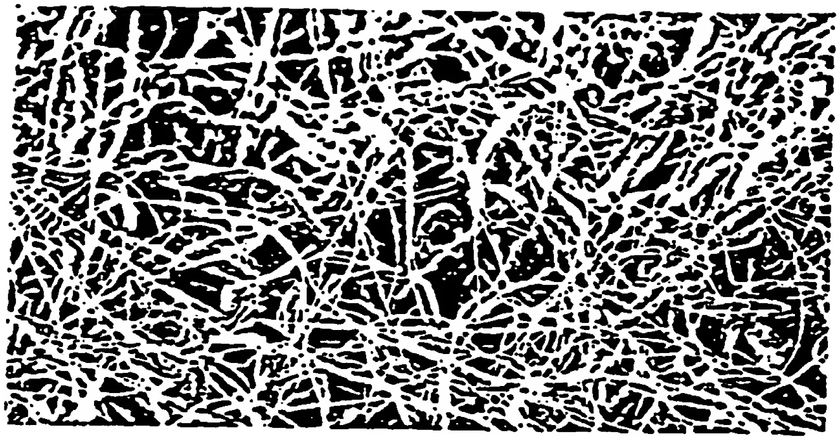

FIG. 3A

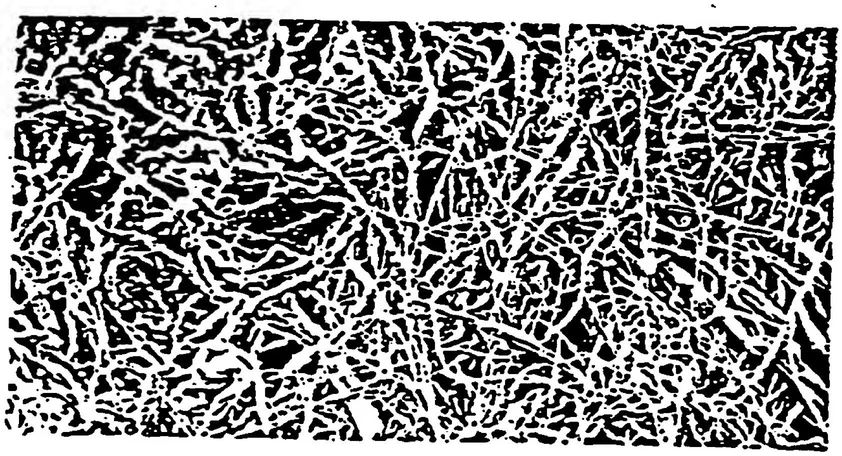

FIG. 3B

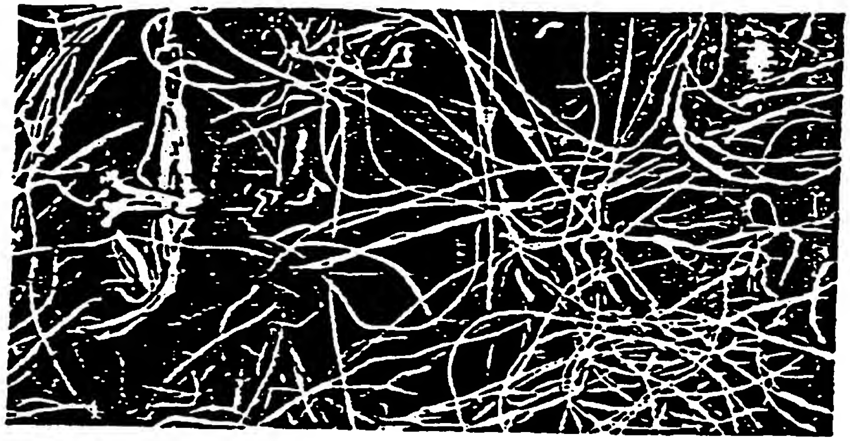

FIG. 4A

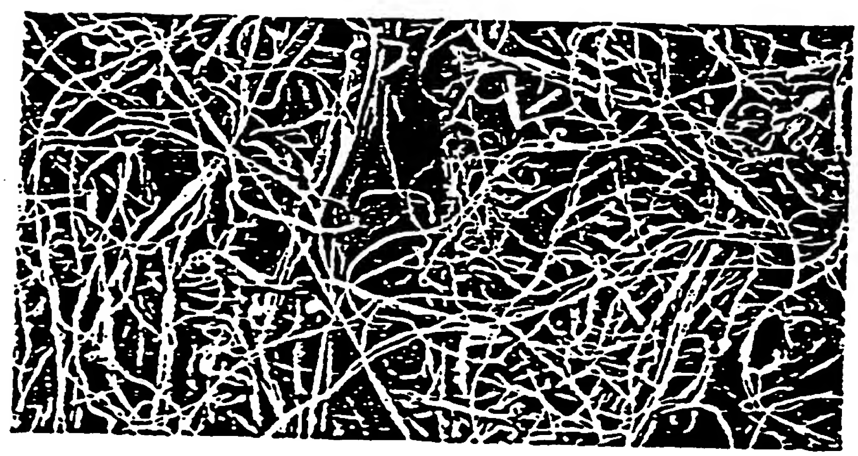

FIG. 4B